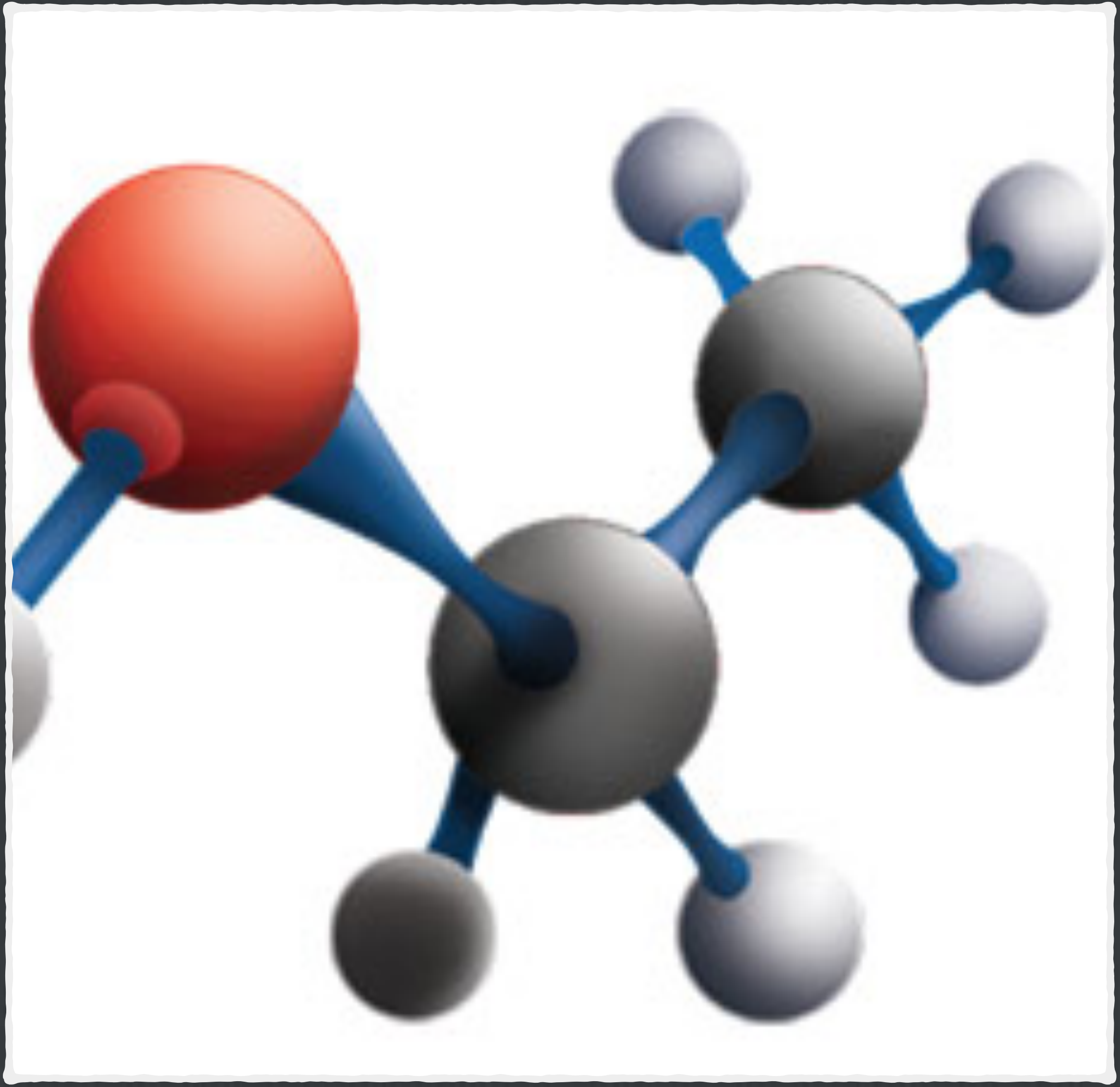
Temperature, Thermal Energy, & Heat

How Temperature and Thermal Energy are related

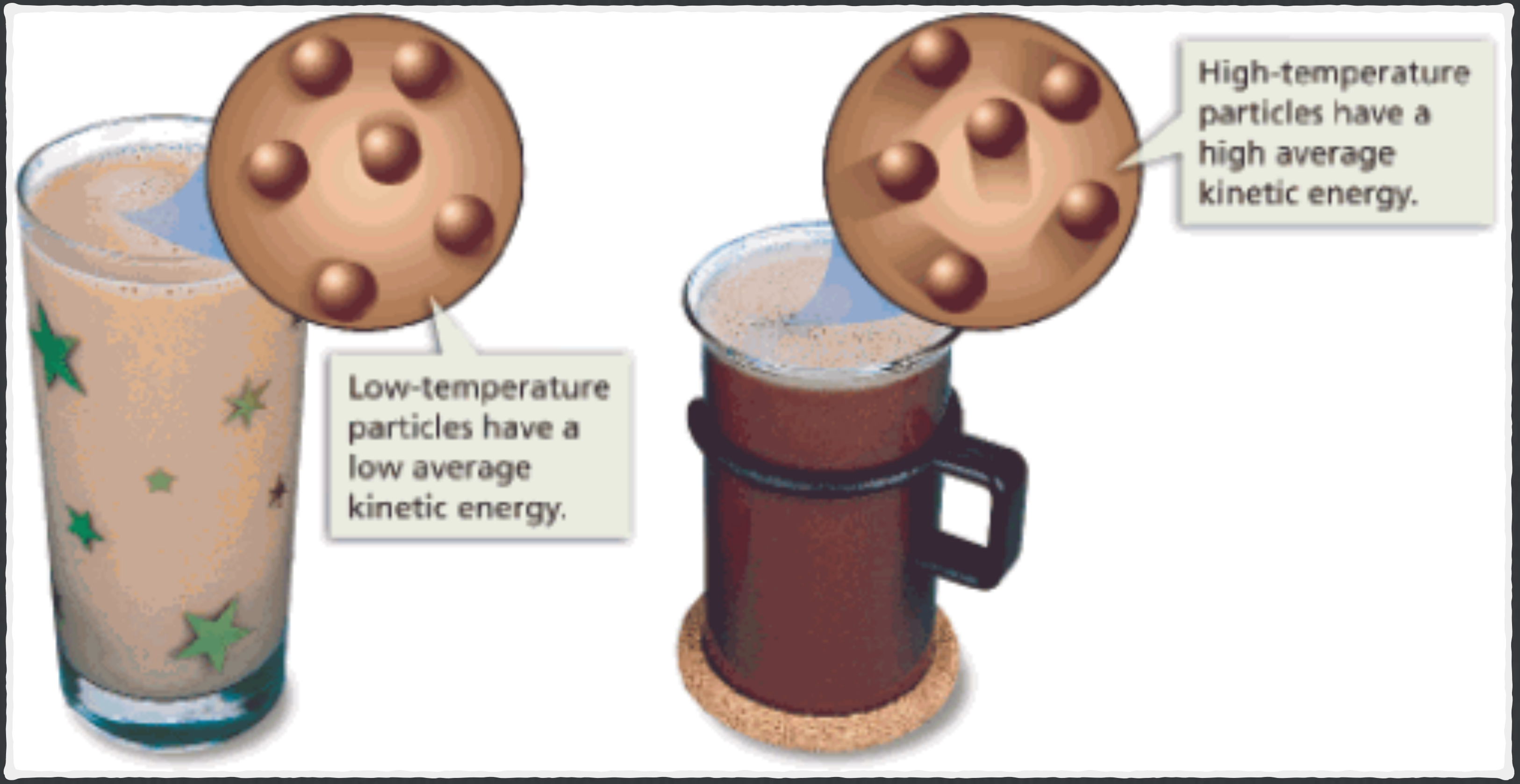
MATTER



Matter is made up of tiny particles. These particles are always moving even if the matter they make up is stationery, or still.

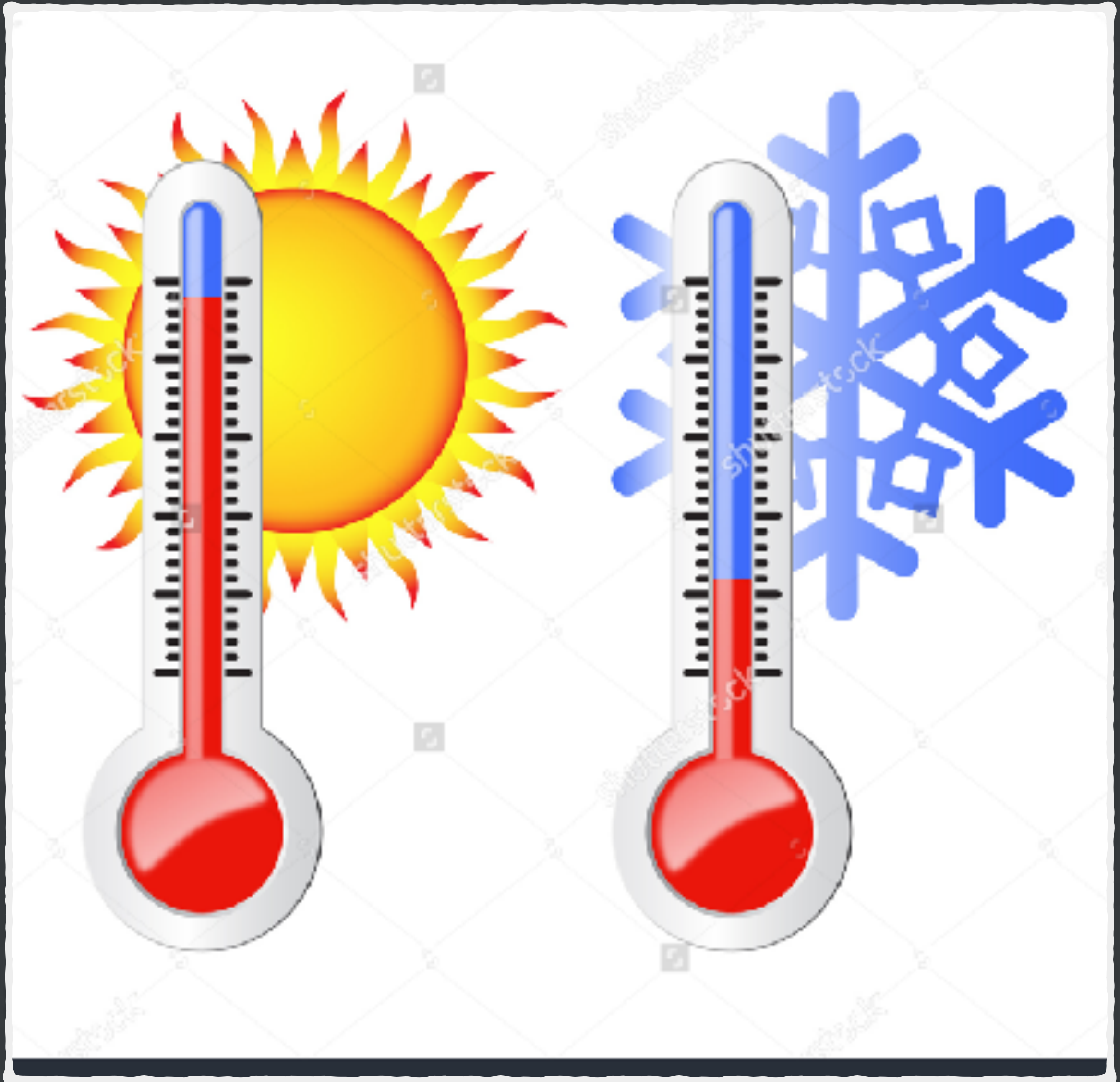
Remember that the energy of motion is called kinetic energy. So all particles of matter have kinetic energy.

TEMPERATURE



The faster particles move, the more kinetic energy they have. Temperature is a measure of the average kinetic energy of the individual particles in matter.

Thermometers

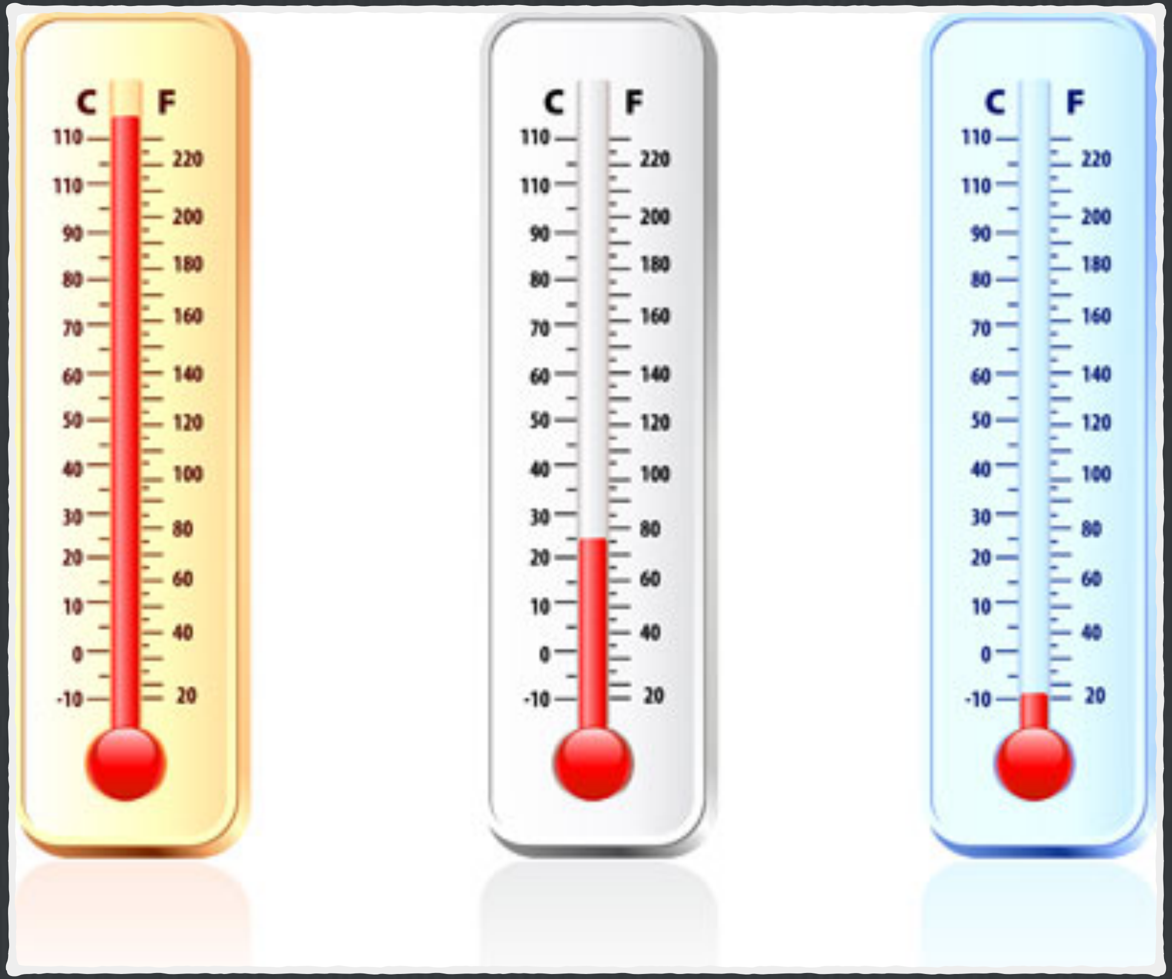


To measure the temperature, you would use a thermometer. A thermometer usually consists of a liquid such as alcohol sealed inside a narrow glass tube.

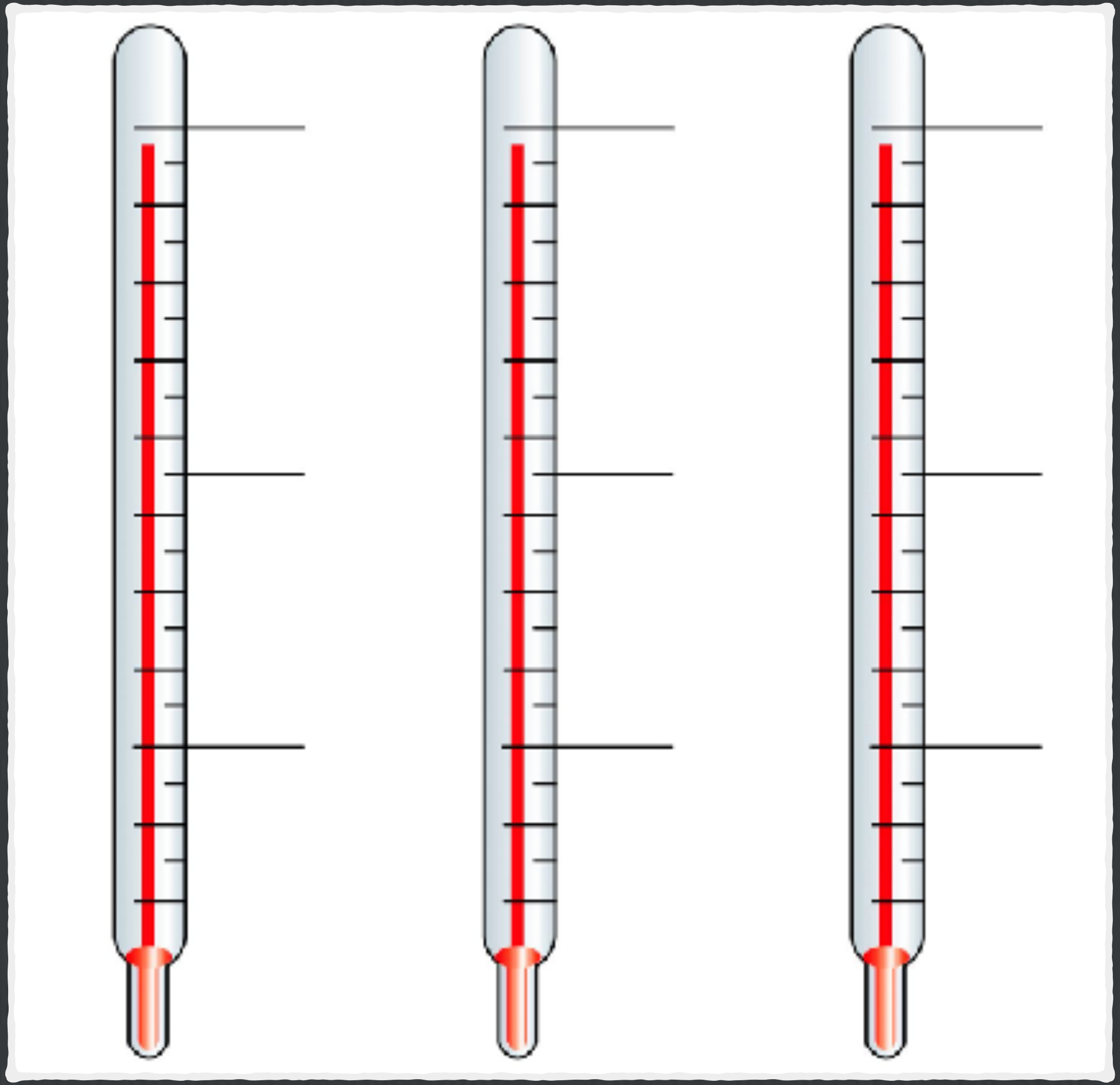
When the tube is heated, the particles of the liquid speed up and spread out so the particles take up more space, or volume. You see the level of the liquid move up the tube.

Thermometers

The reverse happens when the tube is cooled. The particles of the liquid slow down and move closer, taking up less volume. You see the level of the liquid move down in the tube.



Reading Thermometers

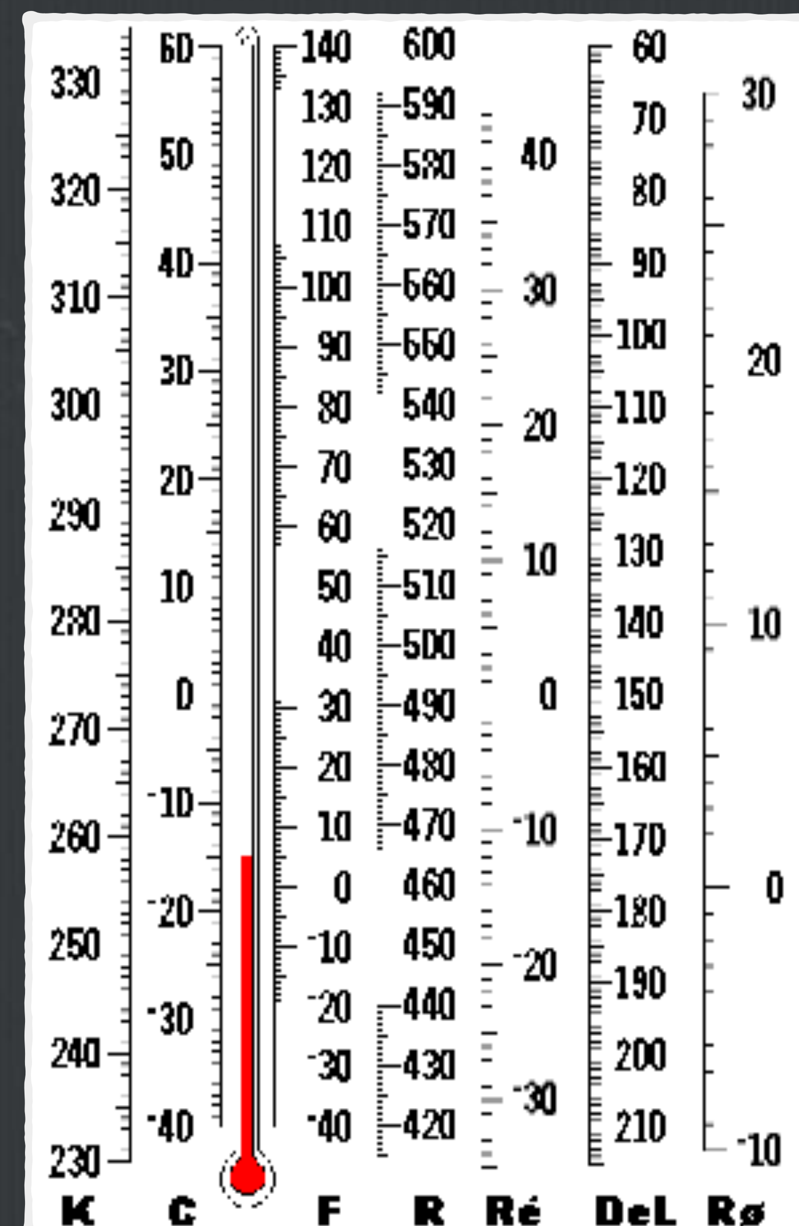


A thermometer has numbers and units, or a scale, on it. When you read the scale on a thermometer, you read the temperature of the surrounding matter. Thermometers can have different scales.

Temperature Scales

The three common scales for measuring temperature are the Fahrenheit, Celsius, and Kelvin scales. Each of these scales is divided into regular intervals.

The temperature scale you are probably most familiar with is the Fahrenheit scale. In the United Staes, the Fahrenheit scale is the most common temperature scale. The scale is divided into degrees Fahrenheit (F). On this scale, the freezing point of water is 32F and the boiling point is 212F.



Celsius

Temperature Scales

Fahrenheit	Celsius	Kelvin	
212	100	373	Boiling point of water at sea-level
194	90	363	
176	80	353	
158	70	343	
140	60	333	
122	50	323	
104	40	313	
86	30	303	
60	20	293	Average room temperature
50	10	283	
32	0	273	Melting (freezing) point of ice (water) at sea-level
14	-10	263	
-4	-20	253	
-22	-30	243	
-40	-40	233	
-58	-50	223	
-76	-60	213	
-94	-70	203	
-112	-80	193	-89°C (-129 °F) Lowest recorded temperature. Vostok, Antarctica July, 1983
-130	-90	183	
148	100	173	

Reference: Ahrens (1994)

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In nearly all other countries, however, the most common temperature scale is the Celsius scale. The Celsius scale is divided into degrees Celsius (C), which are larger units than degrees Fahrenheit. On the Celsius scale, the freezing point of water is 0C and the boiling point of water is 100C.

Kelvin

The temperature scale commonly used in physical science is the Kelvin scale. Units on the Kelvin scale, called kelvins (K), are the same size as degrees on the Celsius scale. So, an increase of 1K equals an increase of 1C.

The freezing point of water on the Kelvin scale is 273K, and the boiling point is 373K. The number 273 is special. Scientists have concluded from experiments that -273C is the lowest temperature possible. No more thermal energy can be removed from matter at -273C. Zero on the Kelvin scale represents -273C and is called absolute zero.

Temperature Scales

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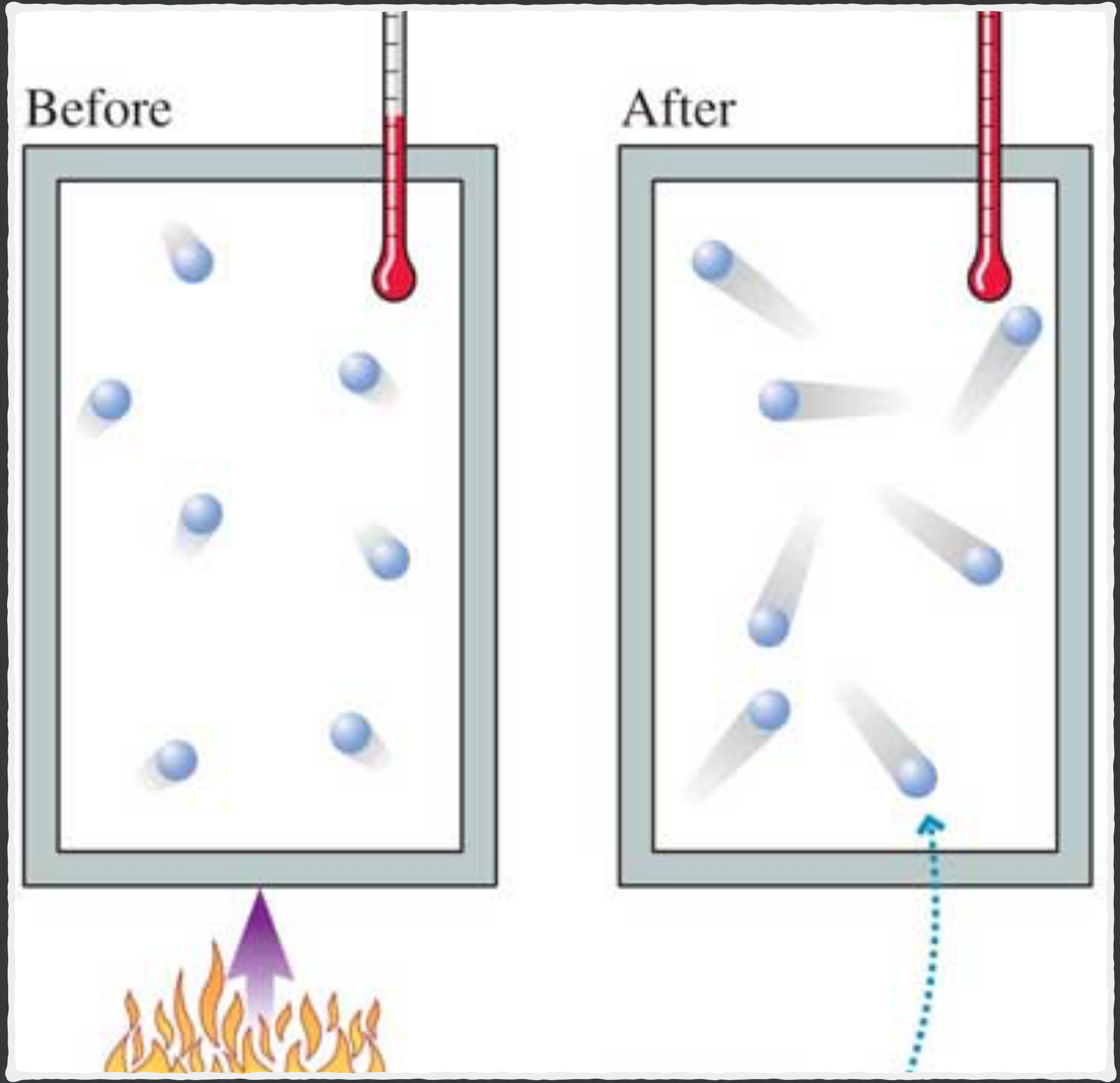
Thermal Energy & Heat

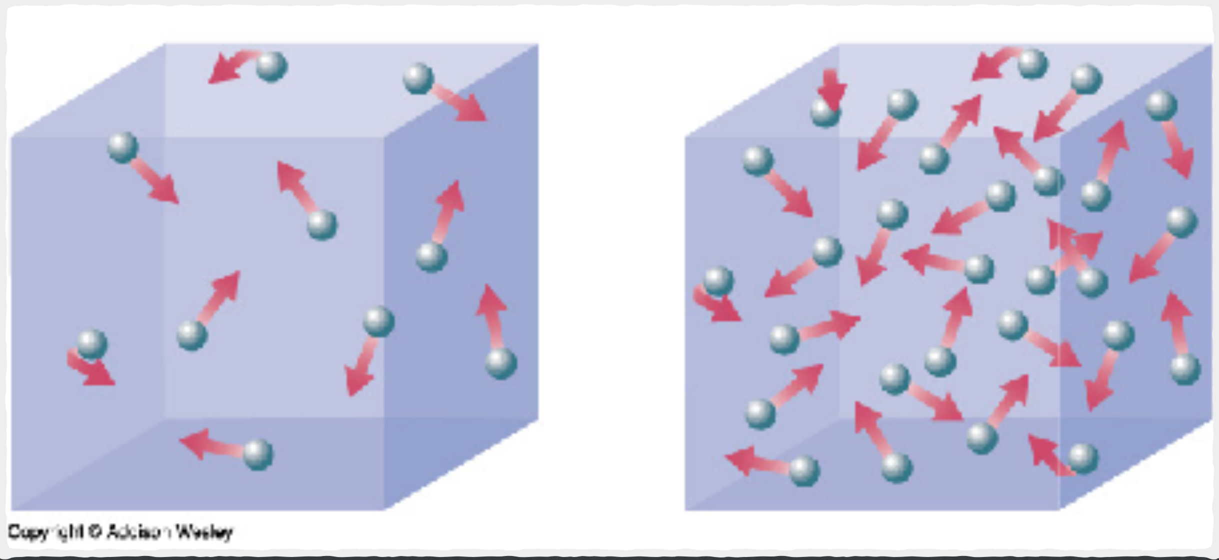


Different objects at the same temperature can have different energies. To understand this, you need to know about thermal energy and about heat.

You may be used to thinking about thermal energy as heat, but they are not the same thing. Temperature, thermal energy, and heat are closely related, but they are all different

THERMAL ENERGY

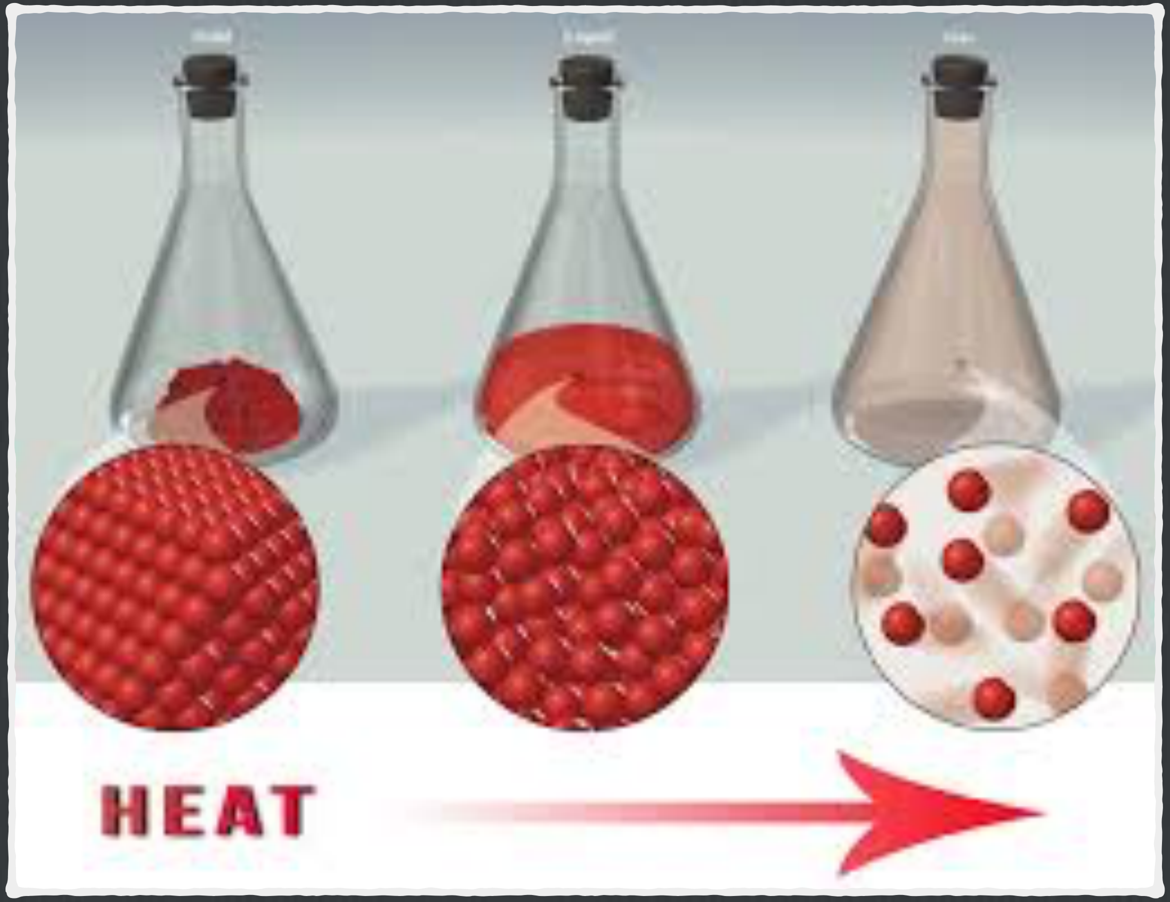
The total energy of all of the particles in an object is called thermal energy, or sometimes called internal energy. The thermal energy of an object depends on the number of particles in the object, the temperature of the object, and the arrangement of the object's particles.



The more particles an object has at a given temperature, the more thermal energy it has. For example, a 1-liter pot of hot cocoa at 75C has more thermal energy than a 0.2-liter mug of hot cocoa at 75C because the pot contains more cocoa particles.

On the other hand, the higher the temperature of an object, the more thermal energy the object has. Therefore, if two 1- liter pots of hot cocoa have different temperatures, the pot with the higher temperature has more thermal energy.

Heat



Thermal energy that is transferred from matter at a higher temperature to matter at a lower temperature is called heat.

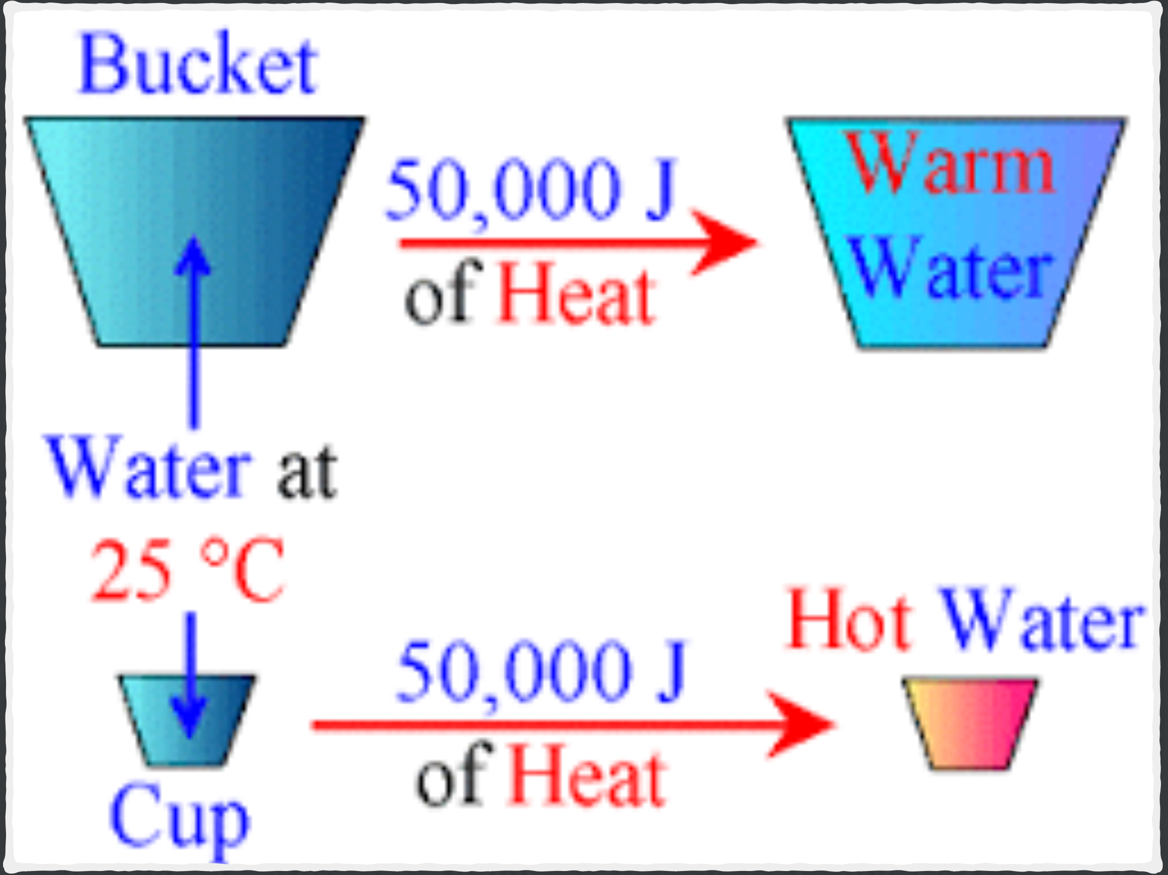
The scientific definition of heat is different from its every day use. In a conversation, you might say that an object contains heat. However, objects contain thermal energy, not heat.

Heat & Joules

Heat is thermal energy moving from a warmer object to a cooler object. For example, when you hold ice in your hand, the ice melts because thermal energy is transferred from your hand to the ice.

Remember that work also involves the transfer of energy. Since work and heat are both energy transfers, they are both measured in joules.

Temperature & Heat



When an object is heated, its temperature rises. But the temperature does not rise at the same rate for all objects.

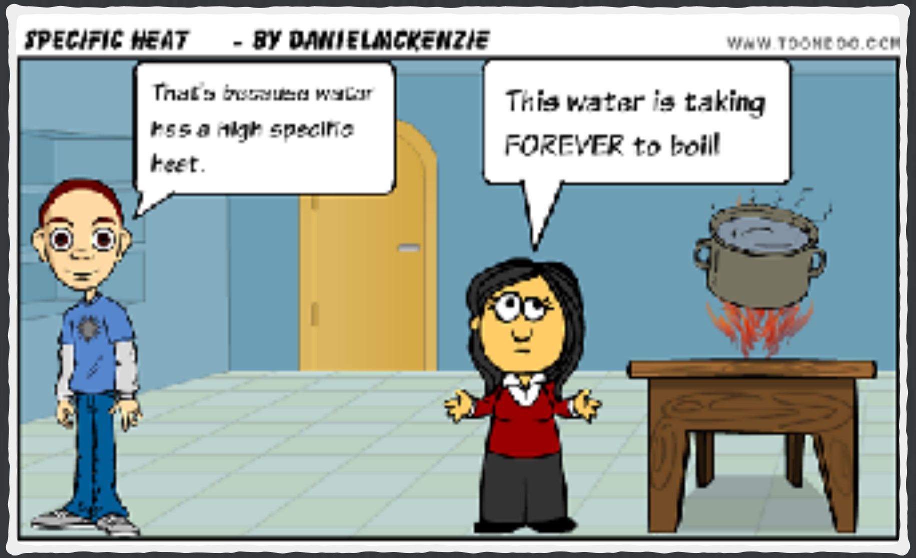
The amount of heat required to raise the temperature of an object depends on the object's chemical makeup. To change the temperature of different objects by the same amount, different amounts of heat are required.

Specific Heat

Scientists have defined a quantity to measure the relationship between heat and temperature change. The amount of energy required to raise the temperature of 1 kilogram of a material by 1 kelvin is called its specific heat.

The unit of measure for specific heat is joules per kilogram-kelvin, or J/(kgXK).

Specific Heats of Selected Materials	
Material	**C (J/kg·K)**
Aluminum	897
Concrete	850
Diamond	509
Glass	840
Helium	5193
Water	4181



Change in Energy

A material with a high specific heat can absorb a great deal of thermal energy without a great change in temperature.

On the other hand, a material with a low specific heat would have a large temperature change after absorbing the same amount of thermal energy.

The energy gained or lost by a material is related to its mass, change in temperature, and specific heat. You can calculate thermal energy changes with the following formula:

Change in energy = Mass X specific heat X change in temperature

Keywords: English - Spanish

Temperature - Temperatura

Scale - Escala

Heat - Calor

Celsius - Celsius

Joules - Julios

Kelvin - Kelvin

Thermal Energy - Energía Térmica

Specific Heat - Calor Especifico